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XII.

THE PECTORAL GROUP OF MUSCLES. By BERTRAM C. A. WINDLE, M.A., M. D. (Dubl.); Professor of Anatomy in the Queen's College, Birmingham.

[Communicated by Professor Macalister, F. R. S., M.R.I.A., May 13, 1889.]

The research, the results of which are embodied in this communication, was undertaken with the view of clearing up, if possible, the relationships of the various factors of the group of pectoral muscles, so-called, to one another, and also to some of those muscles generally described as parts of the panniculus carnosus.

In carrying it out, I have dissected the muscles of this region in a large number of mammals, the opportunity of examining many of which I owe to the kindness of Mr. P. L. Sclater, F. R. S., and Mr. F. E. Beddard, M. A., the Secretary and Prosector, respectively, of the Zoological Society of London, to both of whom I desire to render my thanks. I have also to express my obligations to my friend, Professor Alexander Macalister, F.R.S., for notes of some of his dissections, and for some valuable suggestions. Besides the sources of information alluded to, I have collated the accounts of these muscles given in such Papers as I have been able to consult, and in which the description afforded was sufficiently definite to be of service.

I have divided this Paper into three sections: the general results being given in the first; the second contains a more detailed account of each of the factors of the group; and the third, of their arrangement and peculiarities in the different families of the mammalia. Finally, I have added a Table of all the animals alluded to, with the arrangement of muscles found in each.

SECTION I.—GENERAL RESULTS.

The lateral sheet of muscle, which is pushed out in the form of a cone by the growth of the anterior limb, becomes split up into various groups by a series of radial fissures. Thus are formed pectoral, dorsal, and occipito-cervical groups of more or less complexity. It is with the first-named that this Paper is concerned. Like the cone of which it formed a part, it, too, may be divided into separate or more or less connected parts by radial fission. And, in a similar manner to the other constituents of the cone, it may undergo another division or lamination by fissures passing in a plane at a right angle to those just mentioned.

Thus, by this double series of cleavages, the originally single sheet of muscle may become divided into a greater or lesser number of completely or partially independent factors, which it becomes necessary briefly to enumerate.

1. *Radial Fission.*—For reasons based chiefly upon the innervation, and to be more particularly alluded to shortly, I regard the division in this direction as being of primary importance, and shall therefore take it first into consideration.

The normal lines of radial division are two in number, by means of which the muscle is divided into three portions.

The anterior of these lines is practically constant in its position when it exists, and commences at the point of junction of the presternum with the meso-sternum. The second and posterior line is more variable in position, but, when present, in the majority of cases it starts either from the junction of the meso- with the xiphi-sternum, or at the apex of the latter. Thus the muscular sheet is cleft into three segments: an anterior, or manubrial; a middle, or gladiolar; and a posterior, or abdominal. It should here be mentioned that the presence of a clavicle may add a clavicular portion to the first-named segment, and that this portion may be independent.

As already stated, I base my opinion that the radial segmentation is of primary importance upon the innervation of the muscular sheet, which must next be dealt with.

2. *Innervation of Pectoral Sheet.*—The pectoral sheet of muscle is supplied by three nerves, in a fairly definite manner, as follows :—

(1). The most anterior nerve is derived from the outer trunk of the brachial plexus, formed by the fifth, sixth, and seventh nerves, or it may be derived from the sixth and seventh only. It corresponds to the external anterior thoracic nerve of human anatomy, and supplies the first radial segment.

(2). The mesial nerve is a little more variable; most commonly it is derived from the inner trunk of the brachial plexus formed by the eighth cervical and first dorsal nerves, and receives a branch of communication from the fifth, sixth, and seventh cervical nerves which may come from these trunks below the anterior nerve, or from that nerve itself. Sometimes the greater part of the nerve appears to be derived from the outer trunk; sometimes from the inner; but the latter is by far the more common condition. In other cases it appears to be derived only from the inner trunk; but I believe that the communicating branch is fairly constant. The portion derived from the inner trunk may be derived directly or indirectly from the third or posterior nerve, which has yet to be described. In any case, the point of origin from the inner trunk is close to that of the posterior or third nerve. This second nerve supplies the second or mesial radial segment. It corresponds to the internal anterior thoracic nerve of human anatomy, which, arising from the inner trunk, receives also a constant and sometimes large branch of communication from the external or upper nerve coming from the outer trunk.

(3). The third nerve is constant in its origin, which is from the inner trunk, formed by the eighth cervical and first dorsal nerves, and is distributed to the muscles of the third radial segment. Where these are extensive the nerve is of corresponding size, and may extend backwards as far as the pelvis, sending branches into the muscle known as the abdomino-humeral panniculus, and communicating with the intercostal nerves, which also appear to assist in the supply of the muscle.

Professor Paterson* has of late drawn attention to this nerve, which he calls the "lateral cutaneous nerve of the thorax," and as to which he remarks:—"This nerve, which is fairly constant as a considerable trunk in

* "The Limb Plexuses of Mammals," Journ. of Anat. and Phys., xxi., p. 611.

mammals, being found in seven out of the ten mammals dissected, may be looked upon as the homologue of the nerve of Wrisberg (lesser internal cutaneous) of human anatomy. Its origin is the same (from the ventral trunks of the eighth cervical and first thoracic nerves): and it supplies the integument of the fold of the axilla, communicating in its course with the intercostal nerves. In these animals, moreover, there is no other nerve corresponding to the nerve of Wrisberg." A similar view is expressed by Professor Birmingham,* and I may at once say that my own dissections are entirely in accordance with it.

Of these three nerves the first is the most definite and distinct in its connexions and distribution, and presents no difficulties requiring consideration. The third is definite in its origin, and not quite so much so in its distribution; whilst the second is the most variable. Thus it ranges from the condition of a fairly independent nerve to one in which it appears to be little more than a branch of the third, with a communication more or less distinct from the first. Corresponding with this condition of the nerves we have certain facts as to the division of the segments. The first nerve is quite definite and distinct, as we have seen; and so is the line of division, when it exists, which cuts off the muscular tract which it supplies. The second and third nerves are more variable in their relations to one another, and in correspondence with this the line of division between the mesial and posterior segments is also variable. I look upon the second and third nerves as drawing a certain number of fibres from the inner cord of the plexus, of which a somewhat differing number may run in either path. This point will have further attention directed to it when the relations of the abdominal segment are under consideration. Disregarding, however, this variability of the second nerve, and allowing that a nerve of some derivation, such as has been described, and corresponding to the internal anterior thoracic of human anatomy, is constantly present, we find each of these segments provided with its own nerve-trunk. It is on this ground that I regard the radial segmentation, by means of the two lines mentioned, as primary; and on this account also I exclude the division which

* "On the Homology and Innervation of the Achselbogen," &c. Proc. of Roy. Acad. Med., Dub. Jour. of Med. Sci., ser. III., No. cii., p. 156, and Journal of Anat. and Phys., xxiii., 206.

may exist between the clavicular and manubrial portions from the category of primary fissures. These three nerves, when necessary, will hereafter be alluded to as anterior, middle, and posterior pectoral.

3. *Lamination of Primary Segments.*—Each of the primary segments may, by a secondary division, in a plane parallel to the surface, be divided into two layers—a superficial and a deep. In some cases there is a suggestion that the division may be trilaminar; but I believe the first-mentioned arrangement to be by far the more common.

Thus, in the anterior segment, there may be present, underneath the superficial manubrial or manubrio-clavicular muscle, a deeper slip arising from the manubrium and first rib. This muscle, which has several names, is occasionally present in man, and is then called pectoralis minimus. In the second segment, again, beneath the superficial muscle, there may be a second deeper, arising from (*a*) the edge of the sternum and the costal cartilages, (*b*) from the costal cartilages alone, or (*c*) from the ribs. The pectoralis minor and reflected part of pectoralis major correspond to part of this muscle. The parts of the third segment are more diverse in their arrangement, but may be, though rarely, divided into superficial and deep parts. This, however, as well as all the other facts concerning the various factors of the pectoral group will have to be dealt with at much greater length in the two succeeding sections. I shall conclude this section with a Table showing the separate parts of the muscular mass with their nerve supply, the names which I shall use throughout this Paper, and those to which they correspond in human myology.

Segment.	Name used in this Paper.	Name in Human Myology.	Nerve.
Anterior,	1. Superficial manubrial, Manubrio-clavicular, 2. Deep manubrial,	Upper part of pectoralis major, Pectoralis minimus,	Anterior pectoral.
Middle,	1. (Superficial) gladiolar, 2. (Deep) costal,	Lower non-reflected part of pectoralis major, Pectoralis minor and reflected part of pectoralis major,	Middle pectoral.
Posterior (or Abdominal),	1. Abdomino-humeral (may be superficial), 2. Pectoralis quartus (may be deep),	Abdomino-humeral panniculus (of comp. anat.), Pectoralis quartus,	Posterior pectoral.

SECTION II.—CONSIDERATION OF INDIVIDUAL MUSCLES.

I must here commence by observing that I have purposely avoided making any mention of certain muscular slips of pannicular or platysmal origin, which in some cases overlie the anterior part of the pectoral group, and pass from thence to the neck or shoulder.

These have close affinities with the pectoral group, and are indeed in most, if not in all cases, largely or entirely derived from it; but as they appeared to me to be hardly germane to the subject in hand, and even to tend to confuse it, I have thought it best to neglect them altogether here.

1. *Superficial Manubrial.*—This muscle is the most constant member of the group; for whilst any one or more of its fellows may be absent, it never is. It is also the most definite in its connexions. It arises from the presternum, and passes transversely, or nearly so, across the thorax, to be inserted into the humerus superficial to all the other parts. With respect to its insertion, two points must be noted. Firstly, it is very commonly associated closely with the deltoid; sometimes so much so, as to practically form a common muscle with it at their insertion. Secondly, it has very constantly—in fact, I may say always—when not fused with the gladiolar, a tendency to expansion at its outer extremity so as to have a very much wider insertion than origin. It is carried downwards, I think, by the connexion with the deltoid of which I have spoken; and it is in this way that it comes to lie, as it sometimes does, over a part, or nearly the whole, of the insertion of the gladiolar part. This also, I think, explains the cases where the upper edge of gladiolar is overlapped throughout a great part of its extent by manubrial. It may, of course, be fused with gladiolar; in fact, this is the more common condition so far as the forms included in my Tables are concerned.* It may be fused with the subjacent deep manubrial, the

* I have purposely abstained from overloading the text in this section with references to different animals, introducing names only where absolutely requisite, since in Section III. and the Tables the conditions of individual forms are sufficiently minutely described.

anterior border being then exceptionally thick; and that in some of these cases it is so fused, is proved by its existence in a fully separated or partially separated condition in nearly allied forms (Sciuridæ). With the superficial manubrial may be associated a pars clavicularis, either fully connected with it or separate. In this connexion should be mentioned the cases (*e. g.* Talpa, Canis aureus) in which the anterior part of the fibres of the superficial manubrial are placed in front of the sternum, have no bony attachment, but are connected solely with those of the opposite side. These fibres, I think, we may fairly consider to be homologous with the pars clavicularis in claviculate animals.

2. *Gladiolar.*—This muscle, though not quite so constant as the one first under consideration, is fairly so, though it is often small in size, notably so in most of the forms belonging to the orders Artiodactyla and Carnivora. It arises from a greater or lesser part of the edge of the sternum, behind superficial manubrial, its fibres being generally more oblique, and sometimes more deeply inserted than the first-named muscle.

It may be connected with manubrial or abdominal, or both. It may also be fused with costal in one of two different ways. In the first form met with amongst the Sciuridæ and others, gladiolar is very small and costal large, and the former on its posterior border, which is extremely thin, is more or less fused with the latter, lying beneath it. In the second case, costal is smaller than gladiolar, and the connexion is of a somewhat different nature, which may best be considered in connexion with the description of the deeper muscle. In some animals, such as Cervulus muntjac and Cariacus macrotis, there is a curious connexion between gladiolar and deep manubrial, which I was for some time at a loss to explain. There is also a tendency to the same thing in some of the Carnivora. I believe that the explanation is to be found in the fact that, in the cases where it occurs, the gladiolar part is very thin and small, as a rule, and the superficial manubrial very large. The process of lamination is, as I have endeavoured to show, one of secondary importance, and may, therefore, occur at different depths. In these cases I believe that the thick superficial

manubrial is segmented off from the deeper part at a more superficial level than usual on account of its very thickness, by which means it comes to pass that the thin gladiolar part becomes connected, not as under ordinary circumstances, with the superficial manubrial, but with the deep. It must finally be said about this muscle that in those forms where there is no costal (*e. g.* Chiroptera), the two muscles may be regarded as existing together in an unsegmented condition.

3. *Deep Manubrial.*—This muscle will require more lengthy treatment than those which have preceded it, from the large amount of attention which it has excited, and the diverse opinions which have been put forward regarding it. It is a rather inconstant muscle, the group in which it is most generally existent being the carnivora. It arises beneath the superficial manubrial, from the edge of the manubrium and adjacent part of the first rib, and passes as a narrow strap-shaped muscle, either to the head of the humerus, the coracoid process of the scapula, or, possibly, occasionally to the fascia over the supra-spinatus or other parts of the posterior surface of the scapula. It is sometimes present, though fused with superficial manubrial; or it may be only just separable from it. It may be connected not infrequently with the anterior border of costal, or, as has already been said, rarely with the anterior border of gladiolar. Much of the confusion which exists concerning this muscle depends upon its relations to a curious muscle of doubtful position, the so-called sterno-scapularis. Mivart and Murie* were amongst the first to call special attention to this muscle in Dasyprocta agouti. They write as follows: "*Sterno-scapular.*—This muscle has a double origin; the larger portion arises from the sternum, between the origins of the first and second portions of the pectoralis major (*i. e.* costal and gladiolar), and is closely invested by them. As it passes upwards it becomes slightly connected with the distal end of the clavicle, about an inch beyond which it unites with the second and smaller portion of muscle, being inserted together with it close to the anterior vertebral angle of the scapula. Some fibres pass over the supra-spinatus, and are attached to the spine of the scapula. The second, and rather smaller

* Proc. Zool. Soc., 1866, p. 398.

portion, arises from the outer side of the base of the manubrium, and from the cartilage of the first rib. Passing forwards, it joins the first portion, as already mentioned. The sterno-scapular is an exceedingly long and narrow muscle. The second smaller portion resembles by its origin, and indeed may be, the subclavius, as Meckel suggests; over it is the larger and not the smaller part, which is unmistakably connected with the outer end of the clavicle, the lesser part having only an aponeurotic attachment to that bone. In the hare there is but one broad origin to this muscle, a small portion on its outer edge adhering firmly to the humeral extremity of the rudimentary clavicle as it passes beneath; whilst its insertion is very extensive, viz. from the vertebral angles of the scapula to the coracoid process, upon the surface of the supra-spinatus. In the rabbit and guinea-pig there are two slips, as in Dasyprocta cristata."

In an earlier Paper on Hyrax capensis,* the same authors had alluded to this muscle thus:—"This rather uncommon muscle arises from the sternum, immediately in front of the origin of the pectoralis minor, and passing over the scapulo-humeral articulation, continues along the upper (anterior) border of the scapula, to be inserted into its anterior superior angle. This muscle is very interesting, because it occurs in the pig and other Ungulata; not, however, that it is exclusively confined to that group, as we found it most unmistakably in the guinea-pig, which we examined on purpose. There is a muscle, described by Meckel as existing in the hare, porcupine, and agouti, extending from the spine of the scapula to the sternum, which evidently is our sterno-scapular, but which he considers rather belongs to the subclavius than forms part of the trapezius, as Cuvier thought."

The late Professor Rolleston,† in a Paper devoted to the muscles of the shoulder expresses his opinion that the sterno-scapular is equivalent to the subclavius. The same view is held by Galton;‡ and Murie, in his Paper on Otaria,§ calls a muscle in this position sterno-scapularis, though in another Paper, on Trichechus,‖ he refuses to express any opinion as to

* Proc. Zool. Soc., 1865, p. 338.
‡ Trans. Linn. Soc., vol. xxvi., p. 528.
† *Ibid.*, p. 609.
§ Trans. Zool. Soc., vol. vii., p. 511.
‖ *Ibid.*, p. 442.

whether it is homologous with subclavius or not. It should be noted that in these animals as well as in the seal the muscle is attached on its outer extremity to the humerus. Murie, writing on Tolypeutes,* alludes to a muscle arising from the expanded end of the first rib, by the sternum, which passes under the clavicle, and is connected with that bone, finally becoming inserted into the tendinous arch between the coracoid and the acromion. Mivart,† in a Paper on Echidna hystrix, speaks of a small thin muscle, arising from the anterior border of the first rib, and inserted into the coracoid process behind the coraco-brachialis. This muscle, he believes, represents subclavius. Cunningham ‡ takes the same view of the sterno-scapular muscle in Thylacinus.

In considering the nature of this muscle, it should first be remembered that two very different muscles may arise from nearly the same point; that is, from the side of the manubrium beneath the superficial muscle and from the adjacent part of the rib. In one group of cases this muscle passes across to be attached to the humerus, and is, in fact, as it has been called, a "presterno-humeral" muscle.

I do not think there can be much doubt about its nature. In all cases where I have examined it I have found its nerve-supply coming from the anterior pectoral, which also supplies the superficial manubrial. In these cases, then, we have to do with a member of the pectoral group, a true deep manubrial.

There are, however, other cases of a different nature. The condition in the rabbit affords a good example for observation, and I have made a careful dissection, with results which I shall now describe. On removing the superficial sheet there is found a deeper and still more extensive layer. Commencing at the posterior part of the sternum, this is attached the whole way up to the anterior end. This sheet is practically without division, the only trace of anything of the kind being where the anterior pectoral nerve passes through it. Its posterior part is attached to the humerus; its anterior forms a kind of cap over the shoulder-joint, and is inserted into the back of the scapula. On account of the extensive nature

* Trans. Linn. Soc., vol. xxx., p. 111. † *Ibid.*, vol. xxv., p. 382.

‡ *Challenger* Reports, vol. xvi., p. 6.

of the sheet, and the way in which it is curved round the point of the shoulder, the anterior border is folded upon itself, the reflected part being the deeper. As this muscle passes under the diminutive clavicle it has an intimate attachment to that bone. Within the hollow of the reflected portion, and therefore deeper than the sheet just under description, is a narrow slip arising from the edge of the sternum and first rib, which passes outwards, and joins the under surface of that portion of the superjacent layer which passes over the shoulder. This condition very closely resembles that described by Murie and Mivart as occurring in Dasyprocta, which description I can confirm from my own dissections. We have now to see the innervation of these muscles. The anterior pectoral nerve passes posterior to the deeper slip, and through the more superficial muscle. It gives no branches to the former. To the posterior part of the latter it gives numerous twigs, and to the anterior it also sends some. It terminates in the upper part of the superficial sheet.

This nerve arises from the sixth and seventh cervical nerves. Besides this nerve there is a second, coming from the same trunks, but a little nearer to their point of origin. It is formed by two branches, the upper of which is derived from the root coming from the sixth nerve to help to form the anterior pectoral, the lower from the seventh nerve, nearer its origin than the second root for the anterior pectoral. This nerve entirely supplies the deep slip, but also sends a small twig into the anterior part of the superjacent muscle. I do not feel able to pronounce a definite opinion regarding this nerve, though I think it must be equivalent to the nerve to the subclavius. It may take a lower origin on account of the very small portion of the fifth nerve which enters into the brachial plexus in the rabbit. If this surmise be correct, then the deeper slip is equivalent to a part, at least, of subclavius. But what of the superjacent muscle? The posterior part is undoubtedly costal, and the anterior part is very closely connected with it. Moreover, the anterior part receives part of its nerve-supply apparently from the anterior pectoral, and part from the higher nerve. I must confess my inability to form any definite opinion as to this anterior part. The whole question of the composition, relations and connexions of the subclavius muscle is one of great complexity, and

worthy of careful study. In the guinea-pig I found only the deeper slip. It is supplied by a nerve coming from the fifth and sixth trunks, higher up than the anterior pectoral, and may be looked upon as subclavius. In the horse (Chauveau) the sterno-prescapularis, or pectoralis of Percival and Bourgelat, arises from the sternum, and is directed "forwards or outwards towards the scapulo-humeral angle, and afterwards reflected upwards and backwards on the anterior border of the shoulder, which it follows to near the cervical angle of the scapula." This is supplied (p. 756) by a nerve "emanating from the sixth and seventh cervical pairs, particularly the former, and passing to the interval free of the sterno-prescapularis (or pectoralis), to ramify exclusively among its fibres." I have not had an opportunity of examining this muscle, and can only very doubtfully consider it as a deep manubrial. Leaving this question, therefore, in a somewhat unsettled state, unfortunately, I must draw attention to the peculiar relations to the deep manubrial of the clavicular portion in Chiroptera, which subject will be fully dealt with in Section III. It has already been mentioned that the deep manubrial occurs occasionally as an abnormality in man. The following account of it is given by Macalister, *Catalogue of Muscular Abnormalities* *:—"Pectoralis minimus is described by Professor Gruber (*Mem de Acad. Impl. de St. Petersburg*, series VII., tom. iii.), but was previously remarked by Böhmer. It lies superficial to the costo-coracoid membrane, and is attached internally to the first rib, to the external border of the rhomboid ligament, and, by a few fibres, to the manubrium sterni. It passes outwards, lying superior and superficial to the pectoralis minor, to be inserted into the coracoid process. This is also noticed by Rosenmüller (*De nonnullis Musculorum Varietatibus*, p. 6). It seems like an outward extension of the præ-clavicularis medialis."

In the two cases in which it was observed by Knott † it arose from the cartilage of the first rib alone. I have seen this muscle on both sides in the same subject, and singly in another case. In two instances its nerve-supply was traced to the external anterior thoracic.

* Trans. Roy. Irish Acad., vol. xxv., p. 51.

† Proc. Roy. Irish Acad., ser. II., vol. iii., p. 417.

4. *Costal.*—This muscle is fairly constant, though it may be absent in an entire group, as in the Chiroptera. On the other hand, it may be of great size, and form in connexion with the abdominal portion the major part of the pectoral, as in Artiodactyla and Carnivora. It has a variable origin; for it may arise from the side of the sternum beneath gladiolar, from the costal cartilages, or from the ribs. In other words, it may shift its origin outwards, and this it does in direct connexion with a decrease in its size in the greater number of cases. That is to say, the smaller the muscle, the more it will be shifted out; or conversely, and perhaps more accurately, when the muscle is large, it tends to have a closer connexion with the edge of the sternum.

Its insertion is also variable, and also shifts according to size. It may extend from the coracoid, or upper part of the humerus, to near the lower end. As the muscle grows smaller it is the lower part of the insertion which is lost, so that it tends to become attached to the head of the humerus or, as in man, to the coracoid process. It may be fused with deep manubrial anteriorly, or, if it extend behind the posterior limit of gladiolar, with abdominal posteriorly. Or, finally, it may be fused with gladiolar, and that, as already mentioned, in two ways. One of these has been discussed, and need not be reverted to. The other claims a little attention. In a fairly numerous list of cases, which embraces forms belonging to different orders, and which are indicated in the Table, costal consists of two parts. One of these is independent of other muscles, and corresponds to pectoralis minor in man. The other is connected posteriorly with gladiolar, and is generally described as its "reflected portion." This part, with the superjacent gladiolar, forms a kind of pocket, with its mouth looking forward. Such a reflected portion of greater or less size is found also in man. In man, and in some other forms, the reflected portion is small; but in others it gradually creeps further forward, until its anterior edge comes to lie quite close to the separate piece, as is the case with many apes; finally, they coalesce, so that two layers of muscles overlie one another, which are fused only at the hinder border.

Such, for example, is the condition in Hydromys chrysogaster, where

the superficial and deep sheets are, as above mentioned, quite separate, save at their hinder border.

Where, then, there is a reflected portion of gladiolar present, I look upon that portion as a remnant of a partly lost costal muscle. It may be the only portion, as in the case of Cyclothurus.

The costal muscle, finally, besides the division into two parts, from loss of some of the intermediate fibres, may, by a similar process, become segmented up into a further number of slips. I regard this as the explanation of the numerous slips present under the superficial muscles in Talpa.

5. *Abdominal.*—Speaking broadly, this muscle arises from more or less of the abdominal surface, passes forward under the other members, and is inserted deeper than them all upon the humerus. But it may be present under a variety of conditions. When most fully developed it is connected anteriorly with either the gladiolar or costal portions, and from this point takes origin from the linea alba, or abdominal aponeurosis, as far back as the pelvis. It is fused laterally with a portion of the dorsal muscle: either latissimus dorsi, or what I look upon as a superficial segmentation of that muscle, the dorsi-humeral panniculus. Under these conditions it is inserted—(1) with the pectoral group, (2) with latissimus dorsi, (3) by a sling between the two, the whole axilla being thus closed in by a muscular sheet. We thus have the condition described by Humphry,* to which, and to his deductions therefrom, I must revert later on. This condition is met with in the Cervidæ and in some Carnivores. The line of lateral separation starts from the point where the nerves and vessels pass from the axilla to the arm, and from this may extend backwards, so that the dorsal and ventral parts are separated from one another. They may then be close to one another (*e. g.* Paradoxurus), or be separated by a greater or lesser interval. When this is the case there is always a tendency for a slip to pass from one side to the other, generally from the dorsal to the ventral, which slip is the so-called achselbogen of Langer, or axillary muscle of Humphry. I shall return presently to this muscle.

* Obs. in Myol., p. 130.

In other cases a part of the abdominal muscle may be connected with the hinder edge of gladiolar and costal, the remainder and posterior portion being independent. In this case the anterior part is supplied by the middle pectoral nerve, the hinder by the posterior. The remarks made upon the mutual relations of these two nerves in Section I. will explain this innervation.

Or again, the anterior part connected with some member of the still more anterior (mesial) segment may be the only one present.

In another group two separate muscles are present which may be referred to under the names of pectoralis quartus and abdomino-humeral. The latter—(1) covers the former, the two being then derived from the same sheet by lamination, a condition which is uncommon, but present in Hypsiprymnus and Castor canadensis; or (2) it may be posterior to the former, which is the most common condition; or, finally, it may be anterior to it, a condition which I only know of in Chlamydophorus. As there is least to be said about it, the abdomino-humeral part may first be disposed of. It arises either from a whole or part of the linea alba, or the aponeurosis covering the rectus or external oblique muscle, and is inserted, as has already been mentioned.

Pectoralis quartus, a name bestowed upon the muscle by Haughton and Macalister, has received a great amount of attention. This may be estimated from the number of names it has received. In his "Monograph of the Myology of the Chiroptera" (p. 136), Macalister enumerates the following: humero-abdominalis (Klein); abdomino-humeralis (Dugès); costo-humeralis (Huxley); chondro-epitrocular (Duvernoy); brachio-abdominalis (Zanker); brachio-lateralis (Humphry); portio-abdominalis pectoralis majoris (Ecker). To these may be added Rolleston's name of pyramidal part of pectoral, as mentioned by Galton. This muscle, especially in its condition in man, when present as an occasional abnormality, can only be understood by remembering that it has a tendency to shift its point of origin outwards; or, perhaps it may be better put, to lose its mesial portion. Thus, it may arise from the linea alba or from the abdominal aponeurosis, in either case as a true abdominal muscle; or it may shift still farther outwards, and arise from the edge of the costal arch; or, finally,

travelling still more from the centre it may take its origin from the lower ribs. It is in this condition that it is usually present in man. Perrin,* however, has described "a partially separated slip associated with the inferior fibres of the pectoral muscle, which arises from the abdominal aponeurosis, soon uniting with the pectoralis major, generally opposite the axillary space. This seems to be an aborted form of the epigastric slip, and also closely simulates the proximal portion of an imperfect form of the chondro-epitrochlearis muscle. It is difficult to decide whether it belongs to the former or to the latter." One of the most recent writers on this muscle, Professor Birmingham (*op. cit.*), points out that this muscle in man is supplied by the internal anterior thoracic nerve, and expresses his belief that it is a segmented portion of the great pectoral. Bearing in mind what has been already said regarding the mutual relations of the middle and posterior pectoral nerves, the innervation strengthens my position, which is, that pectoralis quartus in man is a portion of the abdominal part of the pectoral group, having frequently, and in fact generally, shifted its origin from the abdomen to the lower ribs. It is almost invariably the anterior part of the abdominal muscle which thus shifts its origin; but that the posterior may so do whilst the anterior remains stationary, is shown by the condition obtaining in Chlamydophorus.

The so-called achselbogen or axillary muscle generally passes from the dorsal muscle to be inserted with the pectoral; as, for example, in Capromys fournieri (Owen), Dasypus sexcinctus (Galton), or man. But it may pass from the pectoral to the dorsal muscles, as I have seen in Nycticebus javanicus, and as Perrin has described in one case in man (*loc. cit.*, p. 235). Humphry (*op. cit.*, p. 131, note) describes a case where both forms co-existed:—"A good illustration of these axillary muscles was presented this winter by a female subject in the Dissecting-room of this University. A slip from the lower edge of the pectoralis, and another from the anterior edge of the latissimus dorsi, in each arm, ran through the axillary space, and meeting, were inserted together into the fascia, covering the coraco-brachialis." The author just quoted looks upon these connecting bands "as a result of imperfect segmentation" of the lateral sheet. Wilson† has recently had an

* Jour. of Anat. and Phys., vol. iv., p. 233. † *Ibid.*, vol. xxii., p. 294.

opportunity of tracing the nerve supply of these bands in two instances occurring in the same subject. On the left side the slip was supplied by a twig from the intercosto-humeral branch of the second intercostal nerve. On the right side the nerve supply came from a branch representing the nerve of Wrisberg. Birmingham gives the internal anterior thoracic nerve as the source of supply, and looks upon the muscle as a derivative of panniculus. From what has been said, I think there can be no doubt, from a survey of an extensive series of dissections, that Humphry's view is correct; that is, that achselbogen is a remnant of the sheet of muscular tissue which extends in some animals from the abdomen to the back, across the side and axilla, as has been described. Wilson's account of the innervation supports this view, since this sheet is supplied by the lateral cutaneous nerve (my posterior pectoral), which, as Paterson has shown, is the homologue of the nerve of Wrisberg, and also by the lateral branches of the intercostal muscles. It may be remarked, that the diverse theories held by authors who have been cited, and by others who might have been mentioned, with regard to pectoralis quartus and achselbogen, are many of them reduced to an agreement, by what I believe to be a right comprehension of the so-called panniculus of the abdomen, namely, that it is the hindermost portion of the members of the pectoral group.

SECTION III.—CONDITION OF THE MUSCLES IN DIFFERENT ORDERS OF THE MAMMALIA.

1. *Monotremata.*—There is but little to be said about the two forms included. The sheet in a radially undivided state extends from the upper part of the thorax to the abdomen. Mivart* mentions a portion of the panniculus as inserted deeper than the pectoral muscle, and this I suppose is a segmented portion lying posterior to that part which is fused with the posterior edge of the middle segment. There is no costal muscle in Echidna, nor apparently in Ornithorhynchus, for the muscle described as

* Trans. Linn. Soc., vol. xxv., p. 382.

pectoralis minor by Owen* is presumably that which Mivart describes as subclavius. It is possible that this muscle may be a deep manubrial, though I think that Mivart's view is more probably right. I have marked this muscle as doubtful in the Table, since I have no facts concerning the innervation to enable me to form a certain conclusion.

2. *Marsupialia.*—In all these forms, except Thylacinus, superficial manubrial and gladiolar form a single sheet. Deep manubrial is present in all except Sarcophilus ursinus, Thylacinus cynocephalus, Phascogale penicillata, and Didelphys azaræ; at least, no mention is made of it in any of these forms; whilst Cunningham† alludes to its absence in the second and third. Thylacinus, which is the most aberrant from *quâ* pectorals, has a superficial manubrial, a large costal abdominal, in the shape of two small slips arising from the linea alba, and fusing with the under surface of the pectoral; but no gladiolar or deep manubrial. A costal is present throughout, and in Phalangista vulpina, Dasyurus viverrinus, and Chironectes variegatus, consists of two parts, one separate and one adhering to the posterior part of gladiolar, and forming its reflected part, a condition which has been already dealt with in Section I. The abdominal portion may exist under one of two or three conditions. Most commonly there appears to be a small muscle, or two small muscles, arising from the linea alba, or aponeurosis of the external oblique (pectoralis quartus), with, more posteriorly, an abdomino-humeral muscle forming the remaining part. Such is the condition in Phascolomys, Phascolarctus, and Dasyurus.

In other cases, as in Hypsiprymnus, the condition is different. Here we have the rare condition of a deep and a superficial portion to the abdominal part; the superficial is very strong, reaches up to, and even encroaches upon, the lower end of gladiolar; some of the fibres, in fact, appearing almost to be inserted into the sternum, whilst others pass into the axilla, and become fused with the tendon of the deeper part which is inserted with it, and with a part of the dorsal muscle which crosses the axilla. The

* Todd's Cycl. of Anat. and Phys., vol. iii., Art. "Monotremata," p. 392.

† *Challenger* Reports, pt. xvi., p. 7.

deeper portion arises from the abdominal aponeurosis, crosses the lower ribs, and is inserted as above described. Both parts are supplied by the posterior pectoral nerve.

3. *Edentata.*—Superficial manubrial and gladiolar are separate, except in Manis dalmanii, Orycteropus capensis, and Bradypus tridactylus. A separate clavicularis exists in Orycteropus, Tatusia, and Chlamydophorus. No form is possessed of a deep manubrial. A costal exists in all, except Bradypus and Chlamydophorus; it may, however, be absent in Dasypus sexcinctus, where Galton * was unable to find it; though, in my specimen, it was distinct, and arose from the second and third ribs. It is evident from Macalister's † observation that, even in individual animals, this muscle may be variable, and still more so in the order as a whole. Thus, he says, "I could not separate pectoralis minor in the Ai (B. tridactylus and B. torquatus), but Professor Humphry found a distinct one in that animal. Meckel found it, as I did; and Cuvier found it, like as in Professor Humphry's."

Of the abdominal segment, a pectoralis quartus is present in most forms, and is of the costal type. In Chlamydophorus it arises from the lateral aspect of the thorax; in Tatusia peba it arises from six ribs; in Dasypus sexcinctus, from the sixth to the ninth. It is present also in Bradypus tridactylus, Orycteropus (very large), Pholidotus, and Tamandua. There is also in some, an abdominal portion arising from the linea alba, and placed anterior to pectoralis quartus, which latter must consequently, in my opinion, be looked upon as the hinder part of the abdominal portion with an outward shifted origin.

4. *Cetacea.*—Superficial manubrial and gladiolar are fused in Globiocephalus, indistinctly separated in Manatus, and apparently only to be distinguished in Balaenoptera by the different direction of their fibres. A deep manubrial is present in Globiocephalus; it is also present in Phocæna (Rapp.),‡ and Lagenorhynchus. Costal in Manatus consists of two parts, one separate, and one connected with gladiolar.

* Trans. Linn. Soc., vol. xxvi., p. 523.

† Trans. Roy. Irish Acad., vol. xxv., p. 339.

‡ As quoted by Murie, Trans. Zool. Soc., vol. viii., p. 274.

5. *Perissodactyla.*—In the horse,* sterno-humeralis corresponds to superficial manubrial, and sterno-aponeuroticus to gladiolar. Sterno-trochineus consists of costal and abdominal fused, and sterno-prescapularis, which extends rather further down than the manubrium, possibly to deep manubrial, and perhaps part of costal. This muscle has been dealt with in Section II. This last muscle is wanting in the tapir.

6. *Artiodactyla.*—The condition in Antelope cervicopus is fairly typical of the class. There is a superficial and a deep manubrial. Gladiolar is small and thin, only reaches about half-way back on the sternum, and is fused at its origin with the subjacent costal, though separate from it for the most part. Costal and abdominal, which are completely fused, form the greater part of the pectoral; the outer edge is continuous with the superficial part of the dorsal muscle, and the whole sheet is inserted, partly under and with the manubrials and gladiolar, partly with latissimus dorsi, and partly by a strong fibrous sling which arches over the biceps and nerves and vessels, thus closing in the cavity of the axilla. This condition of costal, abdominal and dorsal, seems to be fairly constant throughout the order. A deep manubrial is wanting (or, at least, is not mentioned as occurring in Camelopardalis, Tragulus stanleyanus, Alces malchis, Oreas canna, and Ovis syriacus). In Sus it is similar to the same muscle in Equus. In Bos it is scarcely to be separated from costal, and in Ovis (Chauveau, *loc. cit.*) it is quite fused with it. In Cervulus muntjac and Cariacus macrotis it is fused with the upper border of gladiolar, a condition alluded to in Section II., and in the former is only just separable from superficial manubrial.

7. *Proboscidea.*—Elephas (Miall and Greenwood)† has separate superficial and deep manubrials, the latter the pectoralis minor of Cuvier and Laureillard, gladiolar and abdominal, but no costal. In Hyrax, superficial manubrial and gladiolar, are fused; there is a separate abdominal, as also a costal, but no deep manubrial, unless the sterno-scapular muscle of Mivart and Murie‡ represent it, which, not knowing its innervation, I am unable to determine. I think, however, that it is probably a subclavius.

* Chauveau, Comp. Anat., p. 233. † Jour. of Anat. and Phys., vol. xii., p. 261.
‡ Proc. Zool. Soc., 1865, p. 329.

8. *Rodentia.*—Superficial manubrial may be fused with gladiolar, or separate from it, as in Lepus cuniculus and L. timidus, Dasyprocta, and Sphingurus; or the line of separation between the two may be marked by a distinct white line, though the fibres are not separable, as in the Sciuridæ. They may be partly separable, as in Cavia cobaya, or joined at their origins, but subsequently becoming separate, as in Coelogenys. There may be a separate clavicular portion as in Dipus and Cynomys melanurus. Gladiolar may be connected with superficial manubrial and also with abdominal, the latter being the case in Erethizon dorsatus, Lagostomus trichodactylus, and Mus musculus. In the Sciuridæ it is small, and its posterior edge has a considerable tendency to become fused with the subjacent costal. Deep manubrial may possibly be present in connexion with costal, as in Lepus cuniculus; or just separable from superficial manubrial, as in Cynomys ludovicianus and Sciurus rafflesii. Its relation to sterno-scapularis has been dealt with in Section II. I think it possible that Owen's* pectoralis minor, in Capromys fournieri, may be this muscle; but the description is not sufficiently definite for an exact determination. In the other Sciuridæ, which I have examined, the upper part of the superficial manubrial is very thick, and consists, I think, of both superficial and deep parts fused together. Costal may be separate or connected with deep manubrial, or with abdominal; or it may consist of two parts, one independent, the other connected with the posterior edge of gladiolar (Hydromys chrysogaster, Sciurus griseus, and S. rafflesi). As an instance of the variability of this muscle, may be cited the family of the squirrels. In Sciurus vulgaris, costal is large and much fused posteriorly, with gladiolar; in S. rafflesi and S. griseus it consists of two parts, as above mentioned; in S. tennenti, only the anterior of these remains, arising from the second and third ribs. Abdominal may be present as an independent muscle, or it may be fused with gladiolar or with costal. It may exist in the form of two muscles, a pectoralis quartus and an abdomino-humeral, lying side-by-side; or the former, arising from the linea alba, may underlie the latter, which is of great size, and fused completely with the dorsal muscle, as in

* Proc. Zool. Soc., 1832, p. 68.

Castor canadensis. Capromys fournieri (Owen, *loc. cit.*) has only a small pectoralis quartus, arising from the three lower ribs, to judge from the description given. In Lagostomus the abdominal and dorsal muscles are connected and attached to a sling across the vessels and nerves, &c., much as in some of the Cervidæ; a similar sling is present in Castor. Dipus has no abdominal muscle; but a slip crosses the axilla from the dorsal muscle, and is inserted beneath the pectorals.

9. *Insectivora.*—I have only had the opportunity of examining three members of this order. Erinaceus and Sorex both have separate superficial manubrials, and are destitute of deep. They have both a costal muscle, Erinaceus* has an abdominal, consisting of two parts, the upper forming the lower edge of gladiolar, the lower being an abdomino-humeral muscle which is connected at its edge with the dorsal muscle. There is no abdominal in Sorex.

The remarkable condition of the humerus in Talpa renders a special description of its muscles necessary, as there is a great amount of division corellated with the extensive use which is made of these muscles by the animal. Their condition has been carefully investigated by Freeman.† He describes the superficial part as consisting of—(1) anteriorly a portion with no bony attachments, but placed in front of the presternum, and connected with its fellow of the opposite side; (2) and (3) small portions arising from the promontory and head of the presternum; and (4) a larger part arising from the whole of the sternum behind the promontory of the manubrium, including the xiphoid cartilage, and from all the sternal ribs. It is very difficult to reduce the muscles in this form to the type, and this is especially the case with regard to those arising beneath the superficial mass. As regards the superficial muscles, I think Freeman is right in considering (1) as the homologue of the clavicular portion.

I did not find (2) and (3) separate in my specimens, which had, however, been a long time in spirit; but, whether separate or fused, I should consider them as equivalent to superficial manubrial. The remaining part (4) is

* *Cf.* Dobson, Proc. Zool. Soc., 1887, p. 395.

† Jour. of Anat. and Phys., vol. xx., p. 201.

obviously gladiolar. As regards deep parts, he describes—(1) a fasciculus from the posterior three-fourths of the crest of the manubrium and the second rib ; (2) behind 1, a larger mass from the second and third ribs ; (3) a small, narrow fasciculus from the promontory of the presternum ; and (4) pectoralis minor, of medium size, and arising from the anterior half of the keel of the presternum, and by a small tendinous slip from the first sternal rib.

That these are all dismemberments of the deep stratum there can, of course, be no doubt; but I have not been able to satisfy myself as to their exact natures and relations.

10. *Pinnipedia.*—In all the three forms mentioned in the Table, superficial manubrial and gladiolar are fused. There is a muscle which apparently is a deep manubrial in Otaria and Trichecus, and also in Phoca (Murie), which however, is destitute of costal. In the two first-mentioned forms, abdominal, which is very extensive, is connected with costal and with the dorsal muscle, and closes the axilla. Murie* doubts whether the deep manubrial may not be a subclavius or sterno-scapular. I have discussed this point in Section II.

11. *Carnivora.*—The rule in this order, so far as the superficial muscles are concerned, seems to be for superficial manubrial to be large and well-marked, and to be fused with gladiolar, which is very small, and thins rapidly off below. The last-mentioned muscle is always small, and passes through a condition of almost complete suppression in Cynictis penicillata to one of entire absence in Mustela vulgaris. Some of the anterior fibres of superficial manubrial may be unattached to bone, and connected only with those of the opposite side; a condition similar somewhat, though less well marked, to that obtaining in Talpa. Here, also, it seems probable that this portion may be looked upon as homologous with the clavicular part in animals possessed of that bone.

Deep manubrial is fairly constant in the order; out of twenty-three forms mentioned in the Table, it is absent, or at least not mentioned, in ten.

* Trans. Zool. Soc., vol. vii., pp. 411–527.

In the case of Paradoxurus typus it is fused with the costal. The costal is always a large muscle—in fact, the largest and most important member of the group. Abdominal is also always present, though often somewhat small. In Lutra and Cynictis it is connected with the dorsal muscle by a sling, as in members of other orders already mentioned.

12. *Chiroptera.*—In this order superficial manubrial and gladiolar are fully connected throughout. There is no deep costal, as a general rule: in fact, Macalister mentions its entire absence, in his Paper in the *Philosophical Transactions.** I once found a small slip, in a specimen of Pteropus medius, arising from the second and third ribs, which was, doubtless, an individual variation. There is, it appears probable, no true deep manubrial in this order, though the clavicular part closely resembles it, so much so that, on dissecting Pteropus medius, I marked this muscle as present. On subsequently reading Macalister's Paper I was led to modify my opinion. His observations on this debatable muscle may be quoted here with advantage: "The second part of the great pectoral, or the pars clavicularis, is variable in size and separateness, completely covered by the sternal part, and small in Cephalotes; it arises from the anterior and sterno-clavicular ligament and the inner half of the under border of the clavicle; it is inserted above the sternal pectoral into the pectoral crest; it lies on the costo-coracoid membrane and the coracoid process. In Vampyrops it is at its commencement completely under cover of the sternal part, but at its insertion it is the more superficial of the two. In Macroglossus and Pteropus, this portion, though in its course and termination on a plane posterior to the sternal part, is less covered at its origin, and passes over the coracoid process. In these it arises from nearly the whole length of the clavicle (two-thirds in Pteropus medius, one-third in P. edwardsi (Humphry), even less in Pteropus edulis); its lower surface is flat and fleshy where it lies on the coracoid, from which it is separated by loose areolar tissue, but no bursa intervenes, and the relation of the parts in nowise partakes of the nature of a pulley. This portion in the Pteropus overlaps the sternal part for one half, and the same is the case in Vespertilio. In Megaderma

* 1872, p. 125.

it is more distinctly separate than in any other species, the anterior cutaneous nerve intervening between it and the pars sternalis; in this species it has much the appearance of the human anomaly, pectoralis minimus, described by Professor Wenzel Gruber of St. Petersburgh; it arises from the clavicle, sterno-clavicular ligament, and the cartilage of the first rib; the insertion is by a special round tendon into the pectoral crest of the humerus. The nature of this second part of the great pectoral has been a subject of difference of opinion. Cuvier, in his "Leçons orales," describes the great pectoral as tripartite, and regards this as its second part. Meckel describes the great pectoral as consisting of a superficial and two deep portions: the first of these, he says, arises from the sternum and clavicle (my dissections, as noticed above, do not bear out the latter part of the statement); but as he did not separate the clavicular deltoid from the sternal pectoral, he looked on the origin of the latter as part of that of the former the second part is clavicular; and the third also, from the clavicle. In their plates of Pteropus, Cuvier and Laurillard figure this muscle as the petit pectoral; Humphry regards it as part of the great pectoral, and corrects Cuvier's error of assigning to it a costal origin. The fact of this muscle and the pars sternalis receiving their nervous supply from the anterior thoracic nerve, a branch of the external cord of the brachial plexus, settles the question of its morphological nature." From all this it appears as if in most, if not in all, cases this muscle is more correctly described as pars clavicularis than as deep manubrial, though I think that a part, at least, of the muscle in Megaderma lyra might fairly claim the latter name. It would, perhaps, be most rational to look upon the muscle as a deep clavicular, being in the same relation to the ordinary clavicular that deep manubrial is to superficial. Abdominal is always well developed in the form of a pectoralis quartus, largest proportionally, according to Macalister, in Noctulina, and smallest in Pipistrellus.

13. *Prosimiæ.*—Save in Loris gracilis, and Galago crassicaudatus, superficial manubrial and gladiolar are separate. There is a separate clavicularis in Tarsius and Galago crassicaudatus, whilst the greater portion of the anterior part of the superficial muscle is clavicularis in Lemur catta. There is no deep manubrial throughout the forms mentioned in the Table. A

costal is present in all of them, but Mivart and Murie* note its absence in a specimen of Gallago alleni. An abdominal portion is present in Chiromys, Tarsius, and (?) Perodicticus.

14. *Primates.*—Throughout this order superficial manubrial and gladiolar are, save as an abnormality, fused; there is no deep manubrial, unless the anterior part of the first portion of costal may represent it in Gorilla. Costal is always present, and not unfrequently in the double condition, where one part is connected with the posterior edge of gladiolar, and one part is independent. Abdominal is generally present, save in the higher apes, and when existent is usually of the pectoralis quartus type.

15. *Homo.*—I have incidentally, in Section II., alluded to my views with regard to the homologies of the different members, constant and occasional, of the pectoral group in man. I need, therefore, do no more here than recapitulate those views.

Claviculo-manubrial is generally fused with gladiolar, though it may be separate; clavicularis also may be distinct from manubrial. Deep manubrial may exist as the pectoralis minimus of Wenzel Gruber. Costal consists of two parts, viz. pectoralis minor and the reflected part of pectoralis major, which, as Henle and others have remarked, is sometimes at its origin thrown outwards upon the ribs. Sometimes only the part near the insertion is really reflected, which is not wonderful in a part of a muscle undergoing regression. Abdominal is represented sometimes by pectoralis quartus. Achselbogen is, I think I have been able to show, a part of the brachio-lateral sheet which may be more especially connected with, or related to, latissimus dorsi or pectoralis major.

A Table of the arrangements of the muscles in various forms is appended. It must be understood that, in the cases where I have not dissected the animal in question, I have interpreted the describer's facts as well as I was able. It is perhaps superfluous to say that as I have, as a rule, only been able to examine one animal of those species which I have dissected, I have been unable to make allowance for individual variations. Such variations, however, while affecting isolated cases, would not, I think, militate against the general conclusions which I have formed.

* Trans. Zool. Soc., vol. vii., p. 1.

TABLE OF PECTORAL MUSCLES AS THEY OCCUR AMONGST MAMMALS.

ABBREVIATIONS, &c.— + = Present. — = Absent. c. w. = connected with (used when two segments are fused with one another). The Reference Number relates to the Paper from which the description is drawn: where none is given, the description is from the Author's own dissections—marked thus ! . ? doubtful. n. m. = no mention of the muscle in the paper quoted from.

NAME OF MAMMAL.	Reference No.	(1.) Superficial Manubrial.	(2.) Deep Manubrial.	(3.) Gladiolar.	(4.) Costal.	(5.) Abdominal.
MONOTREMATA.						
Ornithorynchus paradoxus, . .	1	+ c. w. 3 & 5	+ ? ?	+ c. w. 1 & 5	—	+ c. w. 1 & 3
Echidna hystrix, ...	2	+ c. w. 3 & 5	+ ? ?	+ c. w. 1 & 5	—	+ c. w. 1 & 3
MARSUPIALIA.						
Phascolomys wombat, . . .	3	+ c. w. 3	+	+ c. w. 1	+	+ pectoralis 4^{tus} and abdo. huml. p.
Macropus major, ...	4	+ c. w. 3	+	+ c. w. 1	+	+ do.
,, minor	5	+ c. w. 3	+	+ c. w. 1	+	+ do.
Hypsiprymnus rufescens, . . .	!	+ c. w. 3	+ small	+ c. w. 1	+	+ see description
Phascolarctus cinereus, . . .	6	+ c. w. 3	+	+ c. w. 1	+	+ pect. 4^{tus} and abdo. huml. p.
Phalangista maculata, . . .	7	+ c. w. 3	+	+ c. w. 1	+	+
,, cavifrons, . . .	8	+ c. w. 3	+	+ c. w. 1	+	+
,, vulpina, ...	9	+ c. w. 3	+	+ c. w. 1	+ part separate, part c. w. with edge of 3.	+
Sarcophilus ursinus, . . .	10	+ c. w. 3	—	+ c. w. 1	+	+
Dasyurus viverrinus, . . .	11	+ c. w. 3	+	+ c. w. 1	+ part separate, part c. w. 3	+ pect. 4^{tus} and abdo. huml. p.
Thylacinus cynocephalus, . . .	12	+	—	—	+	+ pect. 4^{tus}
Phascogale penicillata, . . .	13	+ c. w. 3	—	+ c. w.	+	+
Didelphys azaræ, ...	14	+ c. w. 3	—	+ c. w. 1	+	+ very large
Chironectes variegatus, . . .	15	+ c. w. 3	+	+ c. w. 1	+ 2 pts. { 1 c. w. 3, 2 indep.	—
EDENTATA.						
Myrmecophaga jubata, . . .	16	+	—	+	+	— (n. m.)
Manis dalmani, ...	17	+ c. w. 3	—	+ c. w. 1 & 5	?	+ c. w. 3
,, multiscutatus, . . .	18	+	—	+	+	— (n. m.)

Name of Mammal.	Reference No.	(1.) Superficial Manubrial.	(2.) Deep Manubrial.	(3.) Gladiolar.	(4.) Costal.	(5.) Abdominal.
EDENTATA—*continued.*						
Tamandua vittata,	19	+	—	+	+	+
Orycteropus capensis,	20	+ c. w. 3, also a separate clavicularis	—	+ c. w. 1	+ Galton (– Macalister)	+
Pholidotus javanicus,	21	+	—	+ c. w. 5	+ ?	+
Cyclothurus didactylus,	22	+	—	+	+ c. w. 3	+
Tatusia peba,	23	+ a separate clavicularis	—	+	+ ?	+
Tolypeutes conurus,	24	+	— ? (Murie)	+	+	+
Dasypus sexcinctus,	! and 25	+	—	+ c. w. 5	+ (– Galton)	+ c. w. 3
Chlamydophorus truncatus,	26	+ a separate clavicularis	—	+	—	+
Bradypus tridactylus,	27	+ c. w. 3	—	+ c. w. 1	—	1
CETACEA.						
Globiocephalus melas,	28	+ c. w. 3	+	+ c. w. 1	+	+
Balaenoptera rostrata,	29	+ fibres of 1 and 3 have different direction	?	+	?	+
Manatus americanus,	30	+ indistinctly separated from 3	—	+	+ 2 pts. {1 c. w. 3, 2 separate	+ ?
PERISSODACTYLA.						
Phacochoerus sumatrensis,	31	+	—	+	+	+ c. w. Lat. Dorsi
Equus,	32	+	+ ?	+	+ c. w. 5	+ c. w. 4
ARTIODACTYLA.						
Sus,	33	+ c. w. 3	+ ?	+ c. w. 1	+ c. w. 5	+ c. w. 4
Camelopardalis giraffa,	34	+ c. w. 3	?	+ c. w. 1	+	?
Tragulus stanleyanus,	35	+ c. w. 3	—	+	+	
Alches malchis,	36	+ c. w. 3	—	+ c. w. 1	+ c. w. 5	+ c. w. 4 and Lat. Dorsi
Cervulus muntjac,	!	+ only trace of separation	+ just separable from 1 + c. w. 3	+	+ c. w. 5	+ c. w. 4 and Lat. Dorsi
Antelope cervicopus,	!	+ c. w. 3 at origin	+	+	+ c. w. 5	+ c. w. 4 and Lat. Dorsi
Cariacus macrotis,	!	+	+ c. w. 3	+ c. w. 2	+ c. w. 5	+ c. w. 4 and Lat. Dorsi
Oreas canna,	!	+ c. w. 3	—	+ c. w. 1	+ c. w. 5	+ c. w. 4 and Lat. Dorsi
Saiga tartarica,	37	+ c. w. 3	+	+ c. w. 1	+ c. w. 5	+ c. w. 4 and Lat. Dorsi
Ovis syriacus,	38	+	—	?	+ c. w. 5	+ c. w. 4
Bos,	39	+ c. w. 3	+ c. w. 4	+ c. w. 1	+ c. w. 4 & 5	+ c. w. 4

Name of Mammal.	Reference No.	(1.) Superficial Manubrial.	(2.) Deep Manubrial.	(3.) Gladiolar.	(4.) Costal.	(5.) Abdominal.
PROBOSCIDEA.						
Elephas indicus, ...	40	+	+	+	—	+
Hyrax capensis, ...	41	+ c. w. 3	—	+ c. w. 1	+	+
RODENTIA.						
Lepus cuniculus, ...	!	+	? + c. w. 4	+	+ c. w. 2	—
,, timidus, ...	!	+	—	+	+	+
Cavia cobaya, ...	!	+ partly c. w. 3	—	+	+	+
Coelogenys paca, ...	!	+ c. w. 3 at origin	—	+	+ c. w. 5	+ c. w. 4
Dasyprocta cristata, ...	! and 42	+	—	+	+ c. w. 5	+ c. w. 4
Hydrochœrus capybara, ...	!	+ c. w. 3	— ?	+ c. w. 1	+ c. w. 5	+ c. w. 4
Sphingurus prehensilis	!	+	—	+	+	+
Erethizon dorsatus, ...	43	+ c. w. 3	—	+ c. w. 1 & 5	—	+ c. w. 3
,, epixanthus, ...	! (44)	+ c. w. 3	—	+ c. w. 1	—	+
Myopotamus coypus, ...	!	+ c. w. 3	—	+ c. w. 1	+	+
Lagostomus trichodactylus, . .	!	+ c. w. 3	—	+ c. w. 1 & 5	+	+ c. w. 3 and Lat. Dorsi
Dipus, ...	!	+ a separate clavicularis	—	+	+	—
Mus decumanus, ...	!	+ c. w. 3	—	+ c. w. 1	+	+
Mus musculus, ...	!	+ c. w. 3	—	+ c. w. 1 & 5	—	+ c. w. 3
Gerbillus longifrons, ...	!	+ c. w. 3	—	+ c. w. 1	+	+ pect. 4tus and abdo. huml.
Hydromys chrysogaster, . . .	! (45)	+ c. w. 3	—	+ c. w. 1	+ 2 pts. {1 c. w. 3, 2 separate	+
Cynomys ludovicianus, . . .	!	+ almost completely c. w. 3.	+ just separable from 1	+	+ c. w. 5	+ c. w. 4
,, melanurus, ...	46	+ c. w. separate clavicularis	—	+ c. w. 1	+	+
Capromys fournieri, ...	47	+ c. w. 3	— ?	+ c. w. 1	+	+
Castor canadensis, ...	!	+ c. w. 3	—	+ c. w. 1	+	+ 2 pts. {deep, superficial. see descriptions.
Myoxus glis, ...	!	+ c. w. 3	—	+ c. w. 1	—	—
Pteromys volans, ...	48	+ c. w. 3	—	+ c. w. 1	+	+
Sciurus vulgaris, ...	!	+ c. w. 3	—	+ c. w. 1	+	+ pect. 4tus and abdo. huml.
,, tennenti, ...	!	+ c. w. 3	—	+ c. w. 1	+	+
,, griseus, ...	!	+ c. w. 3	—	+ c. w. 1	+ 2 pts. {1 c. w. 3, 2 separate	+
,, rafflesi, ...	!	+ c. w. 3	+ just separable from 1	+ c. w. 1	+ 2 pts. {1 c. w. 3, 2 separate	+

Name of Mammal.	Reference No.	(1.) Superficial Manubrial.	(2.) Deep Manubrial.	(3.) Gladiolar.	(4.) Costal.	(5.) Abdominal.
INSECTIVORA.						
Erinaceus europæus, ...	!	+	—	+ w. pt. of 5	+	+ 2 pts.
Sorex vulgaris, ...	!	+	—	+	+	—
Talpa europæa, ...	! and 49	+	see description	+	see description	
PINNIPEDIA.						
Phoca vitulina, ...	50	+ c. w. 3	+ (Murie)	+ c. w. 1	—	+
Otaria jubata, ...	51	+ c. w. 3	+	+ c. w. 1	+	+ c. w. 4 and Il.
Trichecus rosmarus, ...	52	+ c. w. 3	+	+ c. w. 1	+	+ c. w. 4 and Il.
CARNIVORA.						
Procyon cancrivorus, . . .	! (53)	+ c. w. 3	+	+ c. w. 1	+	+
Cercoleptes caudivolvulus, . .	54	+ c. w. 3	—	+ c. w. 1	+	+
Ursus americanus, ...	55	+ c. w. 3	+	+ c. w. 1	+	+
Nasua narica, ...	56	+ c. w. 3	+	+ c. w. 1	+	+
,, fusca, ...	57	+ c. w. 3	+	+ c. w. 1	+	+
Meles taxus, ...	!	+ c. w. 3	+	+ c. w. 1	+	+
Mustela foina, ...	58	+ c. w. 3	+	+ c. w. 1	?!	+
,, vulgaris, ...	!	+	—	—	+	+
,, furo, ...	!	+ c. w. 3	+	+ c. w. 1	+	+ small
,, putorius, ...	!	+ c. w. 3	+	+ c. w. 1	+	+
Lutra vulgaris, ...	!	+ c. w. 3	+	+ c. w. 1	+	+
Viverra civetta, ...	59	+ c. w. 3	—	+ c. w. 1	+	+
Herpestes griseus, ...	!	+ c. w. 3	—	+ c. w. 1	+	+
Paradoxurus typus, ...	!	+	+ c. w. 4	—	+ c. w. 2	+
Cynictis penicillata, ...	!	+	+	+	+	+
Canis domesticus, ...	! and 60	+ c. w. 3	+	+ c. w. 3	+	+
,, aureus, ...	!	+	—	+	+	+
Hyæna crocuta, ...	61	+ c. w. 3	—	+ c. w. 1	+	+
Proteles cristatus, ...	62	+ c. w. 3	—	+ c. w. 1	+	+
Felis domestica, ...	! and 63	+ c. w. 3	+	+ c. w. 1	+	+
,, caracal, ...	64	+ c. w. 3	—	+ c. w. 1	+	+
,, jubata, ...	65	+ c. w. 3	—	+ c. w. 1	+	+
,, tigris, ...	66	+ c. w. 3	—	+ c. w. 1	+	?

Name of Mammal.	Reference No.	(1.) Superficial Manubrial.	(2.) Deep Manubrial.	(3.) Gladiolar.	(4.) Costal.	(5.) Abdominal.
CHIROPTERA.						
Pteropus edulis, ...	67	+ c. w. 3 a separate clavicularis	—	+ c. w. 1	—	+
,, medius, ...	! and 68	+ c. w. 3, do.	—	+ c. w. 1	found once (!)	+
Macroglossus minimus, . . .	69	+ c. w. 3, do.	—	+ c. w. 1	—	+
Eleutherura marginata, . . .	70	+ c. w. 3, do.	—	+ c. w. 1	—	+
Cephalotes pallasii, ...	71	+ c. w. 3, do.	—	+ c. w. 1	—	+
Cynonycteris amplexicaudata, . .	72	+ c. w. 3, do.	—	+ c. w. 1	—	+
Rhinolophus ferrum-equinum, . .	73	+ c. w. 3, do.	—	+ c. w. 1	—	+
Megaderma lyra, ...	74	+ c. w. 3	+ ?	+ c. w. 1	—	+
Artibeus jamaicensis, ...	75	+ c. w. a separate clavicularis	—	+ c. w. 1	—	+
Vampyrops vittatus, ...	76	+ c. w. 3, do.	—	+ c. w. 1	—	+
Vespertilio murinus, ...	77	+ c. w. 3, nearly comp. sep. clav.	—	+ c. w. 1	—	+
Vesperugo pipistrellus, . . .	78	+ c. w. 3, trace of division, stern and clav.	—	+ c. w. 1	—	+ {smallest proportionately
Scotophilus hesperus, . . .	79	+ c. w. 3, nearly comp. sep. clav.	—	+ c. w. 1	—	+ very small
Noctulina altivolans, ...	80	+ c. w. 3, do.	—	+ c. w. 1	—	+ {largest proportionally
Plecotus auritus, ...	! and 81	+ c. w. 3, sep. clav.	—	+ c. w. 1	—	+
PROSIMIA.						
Chiromys madagascarensis, . .	82	+	—	+	+	—
Tarsius, ...	83	+ separate clav.	—	+	+	—
Nycticebus javanicus, . . .	! and 84	+	—	+	+	+
Loris gracilis, ...	85	+ c. w. 3, no. clav.	—	+ c. w. 1	+	+
Lemur catta, ...	86	+ chiefly clav.	—	+	+	+
,, varius, ...	87	+ no clav.	—	+	+	+
Galago crassicaudatus, . . .	88	+ c. w. 3, very small clav.	—	+ c. w. 1	+	+
Perodicticus, ...	89	+	—	+	+	?
PRIMATES.						
Hapale jacchus, ...	! (90)	+ c. w. 3	—	+ c. w. 1	+ 2 pts. {1 c. w. 3, 2 separate	+
Midas rosalia, ...	! (91)	+ c. w. 3	—	+ c. w. 1	+ do. do.	+
Cebus capucinus, ...	!	+ partly c. w. 3	—	+	+	+
Pithecia, ...	92	+ c. w. 3, no clav.	—	+ c. w. 1	+	+
Callithrix, ...	93	+ c. w. 3	—	+ c. w. 1	+	?

Name of Mammal.	Reference No.	(1.) Superficial Manubrial.	(2.) Deep Manubrial.	(3.) Gladiolar.	(4.) Costal.	(5.) Abdominal.
PRIMATES—*continued.*						
Cynocephalus hamadryas, . . .	94	+ c. w. 3	—	+ c. w. 1	+	+
,, maimon, . . .	!	+ c. w. 3	—	+ c. w. 1 & 4	+ 2 pts. {1 c. w. 3, 2 separate	+
,, anubis, . . .	95	+ c. w. 3	—	+ c. w. 1 & 4	+ c. w. 3 infy.	+
Macacus erythræus, ...	!	+ c. w. 3	—	+ c. w. 1 & 4	+ 2 pts. {1 c. w. 3, 2 separate	+
,, cynomolgus, . . .	!	+ c. w. 3	—	+ c. w. 1	+ do. do.	+
,, radiatus, ...	96	+ c. w. 3	—	+ c. w. 1 & 4	+ do. do.	?
Semnopithecus entellus, . . .	97	+ c. w. 3	—	+ c. w. 1	+	?
Cercopithecus diana, . . .	!	+ c. w. 3	—	+ c. w. 1	+	+
,, callitrichus, . .	98	+ c. w. 3	—	+ c. w. 1	+	+
,, sabæus, . . .	99	+ c. w. 3	—	+ c. w. 1	+	+
,, campbelli . . .	!	+ c. w. 3	—	+ c. w. 1	+	+
,, cephus, . . .	!	+ c. w. 3	—	+ c. w. 1	+	+
Hylobates leuciscus, . . .	100	+ c. w. 3, a clav.	—	+ c. w. 1	+	—
Orang-outang, ...	! and 101	+ c. w. 3, no clav.	—	+ c. w. 1	+	—
Gorilla engena, ...	102	+ c. w. 3, separate clavicularis	? + (see 4)	+ c. w. 1	+ 2 pts. {1 R. 1–4 2 R. 2–6	—
Troglodytes niger, ...	103	+ c. w. 3	—	+ c. w. 1	+	—
Homo, ...	104	+ c. w. 3, or occasionally separate, clavicular 1 & 3	present occasionally = p. minimus	+	+ 2 pts. {1 p. minor 2 reflected of p. mag.	occasionally present = pect. 4^{tus}

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